# NAVFAC EXWC Tests Feasibility of Smart Water Conservation System

## System May Significantly Reduce Potable Water Consumption

**A RECENT DEMONSTRATION** project by engineers from the Naval Facilities Engineering Command (NAVFAC) Engineering and Expeditionary Warfare Center (EXWC) investigated the use of a smart water conservation system for landscape irrigation.

In some regions of the United States, such as the Southwest, water use is highly regulated due to drought conditions, and implementation of water-saving systems has become a necessity. In addition, Executive Order 13693, Planning for Federal Sustainability in the Next Decade, requires the federal government to reduce potable water usage 36 percent by 2025.

Smart water conservation systems offer a way to meet these challenges by reducing potable water use while maintaining a reasonable amount of green space and landscaping on Department of Defense (DoD) properties.

In an effort to quantify the pros and cons of a smart water conservation system, the DoD's Environmental Security Technology Certification Program (ESTCP) sponsored the installation of a system at Naval Base Ventura County (NBVC) Port Hueneme, California in collaboration with the Navy Environmental Sustainability Development to Integration (NESDI) program and the U.S. Army Corps of Engineers Construction Engineering Research Laboratory.

The demonstration was conducted by NAVFAC EXWC engineers who specialize in environmental and energy projects, including water conservation.

### The Demonstration Site

The system was installed in early 2013 at NBVC Port Hueneme's Building 1100, which provides office space for over 500 engineers, scientists and support staff.

The demonstration area included a "smart plot" along with a control plot to demonstrate the new system alongside the current, more traditional irrigation system. Both the smart and control plot have a turf area as well as an area of myoporum (a native ground cover) covering 6,500 square feet. These plots are roughly equivalent in size and location.

### About the System

The smart water conservation system includes an integrated suite of commercially available technologies for irrigating landscape:

- Evapotranspiration (ET) irrigation controller
- Centralized and site-specific sensor inputs (ET, rain, soil moisture and leak detection)

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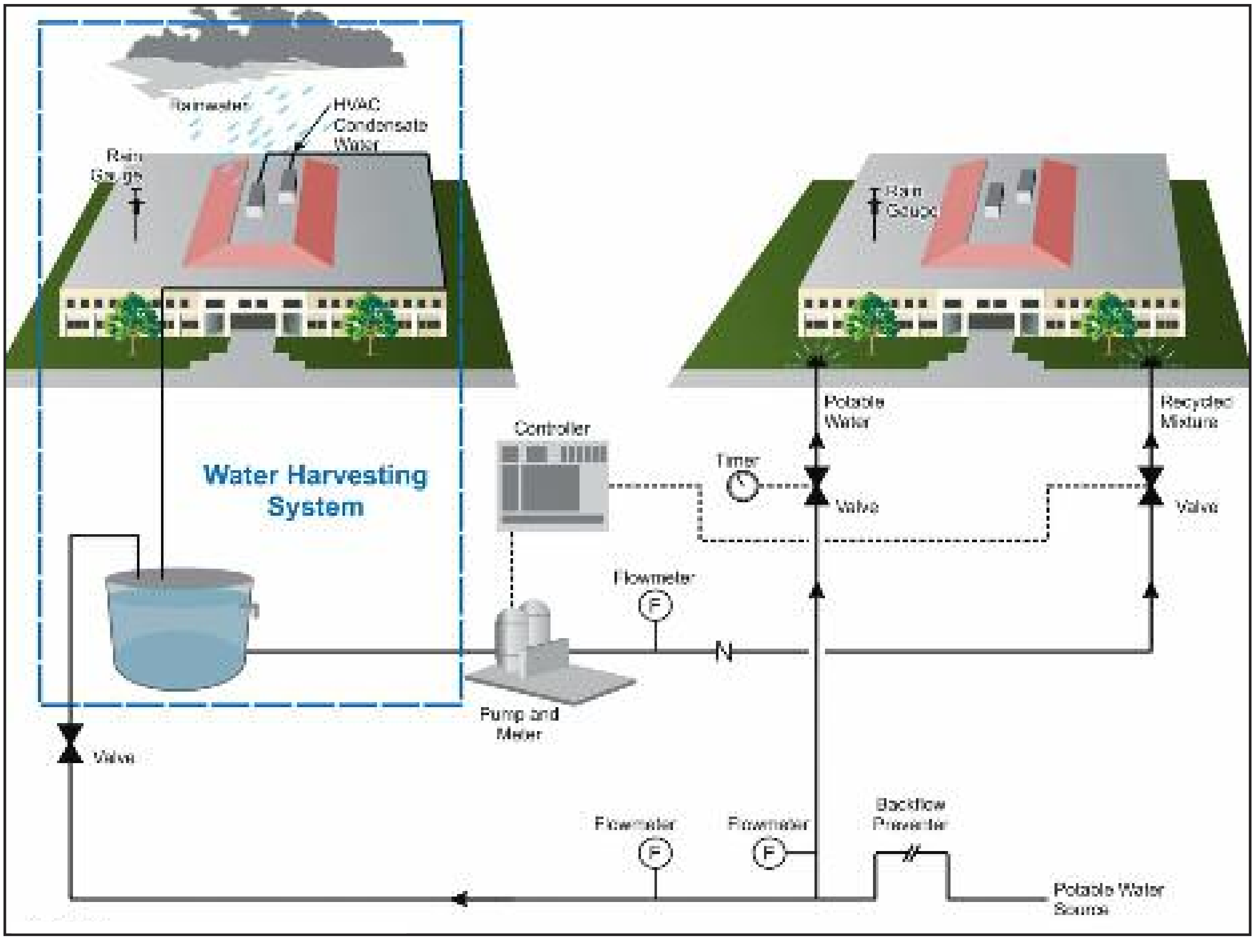


Schematic of the smart water conservation system and a traditional irrigation system.

- Efficient sprinkler distribution systems
- Water harvesting of rain and air conditioning condensate

## Rainwater & Heating Ventilation & Air Conditioning Condensate Water Harvesting System

The water harvesting subsystem is comprised of commercially available plumbing and an underground storage tank (UST) constructed on the west side of Building 1100. Heating ventilation and air conditioning (HVAC) condensate and rainwater from the building's rooftop is diverted to the 17,000-gallon underground tank and subsequently pumped to irrigate the smart plot.

For a large facility, such as Building 1100, an HVAC system can potentially generate 0.4 to 5.3 gallons per hour of condensate water, depending on the cooling load placed on the chillers (approximately 25,000 gallons annually).

Three downspouts from the western half of the building's rooftop were rerouted to the 17,000-gallon harvest tank. The location served by these three downspouts covers an area of 29,400 square feet. Rainwater discharging through these downspouts during an average year (12 inches of rain per year) could produce over 200,000 gallons of rainwater—well over the required amount needed for the smart plot. If funding is available, a larger tank could be installed downstream of this system to take advantage of this water source instead of letting it overflow to the storm sewer system.

The UST was constructed with modular polyethylene cells assembled together with an overall dimension of 14 by 40 by four feet (2,240 cubic feet). The nested cells were enclosed with a 36-millimeter thick polypropylene liner to hold water. Two manholes were installed on the top of the tank to allow installation of a submersible pump, float switches and ancillary piping. Holes were installed on one side wall to accommodate ports for the inlet harvested water, outlet pressure irrigation piping and

Construction and installation of a 17,000-gallon UST for the storage of harvested water.
*Gary Anguiano*

electrical conduit. The UST was covered with a two-foot cap of native soil and sand which can support a vehicle of 16,000 pounds without adverse impact to the UST.

A one-horsepower, 110-volt submersible pump was installed at the bottom of the UST to irrigate the smart plot with harvested water. The pump was protected from running dry with the use of two low level float switches. These switches enable the pump to automatically shut down when water levels are too low for operation.

If rainwater collected from the rooftop and condensate water from the HVAC system were of insufficient volume to keep the pump primed or irrigate the smart plot, then potable water was obtained. When activated by the second float switch in the UST and directed by the ET controller, the flow control valve opened, allowing potable water to flow into the UST. The makeup water level within the UST was set at a minimum to allow harvested water to replenish the supply to the maximum extent possible.

The rain water harvest system included first flush diverters that redirect the first part of a rain event—which contains the greatest concentration of pollutants and debris—away from the harvest tank into the storm sewer. This lessens the possibility of contaminants clogging the sprinklers, flow meters or other components. Two first flush diverters types were used; a commercial-off-the-shelf (COTS) system and a Navy-built system made of standard plumbing hardware. The Navy system used a volumetric approach for first


Demonstration area immediately north of Building 1100 depicting the smart plot, control plot, approximate rainwater harvesting area and the underground water storage tank.
*Google Maps*

Operators are able to program the system to operate/irrigate based on site- and area-specific conditions.

flush diversion, whereby when 100 gallons of water was captured the following rainwater is diverted to the harvest tank. After the storm event, the diverted 100-gallon volume slowly drains from the diverter over the next 72 hours via a weep hole connected to the storm sewer. The COTS diverter used a flow based approach and is designed to reset itself after the rain event. In addition to the first flush diverters, a floating filter screen was installed inside the tank prior to the pump to prevent debris from entering the underground sprinkler system.

## Advanced ET Controller

The main user interface for the smart water conservation system is a programmable logic controller. Through the use of the ET controller, operators are able to program the system to operate/irrigate based on site- and area-specific conditions. Basic functionality of the smart irrigation modular controller includes the following:

- Control over eight irrigation systems (upgradeable up to 32 irrigation zones)
- Four separate programmable settings to input different start times, system timing duration and watering days
- Self-diagnostic feedback to identify any operational issues
- Remote features, such as manual operation, program adjustment, as well as dial and switch settings accessible via personal computer, radio signal or cellular network

The controller interfaces with various sensors to efficiently irrigate the smart plot, including: ET gauge to calculate the irrigation run time correlated to existing weather conditions; a soil moisture sensor that terminates irrigation if actual soil moisture meets the programmed set-point; and a rain gauge that terminates irrigation upon a rain event.



Control plot and smart plot at Building 1100.
*Gary Anguiano*

## Water-efficient Sprinkler, Flow Meters & Pressure Regulating Device

Efficient irrigation hardware, including pipeline design, multiple high-efficiency sprinkler nozzles, pressure-regulating valves and a flow meter were also part of the smart water conservation system. The sprinkler nozzles were designed to provide even water distribution within a 10-foot radius. The regulating valve device minimizes water loss caused by excessive pressure to the sprinkler nozzle, which can cause overspray.

A flow meter was installed in the irrigation pipeline as a subsystem of the ET controller. The controller can be programmed to alert facility operators when the flow rate is above a specified value. High flow rates occur as a result of


CLOCKWISE FROM LEFT: Smart irrigation modular controller, ET gauge, uncovered ET gauge, rain gauge.
*Gary Anguiano*

**Constant volume first flush diverters installed at the base of Building 1100.**
*Gary Anguiano*

a breach in the pipeline or a broken sprinkler nozzle. If sprinkler nozzles are accidently broken by lawn equipment or maintenance crews, then the flow rates exceed normal flow patterns and the problem may not be discovered for many days. The controller can detect these changes in flow rate and shut down the irrigation system or provide an email alert to operators.

In addition to tracking potential leaks in the system, the flow meters also tracked the volume of both harvested and potable irrigation water used during the demonstration period. Data were collected monthly and totaled at the end of the two years to assess overall and individual performance of the system.

## Performance Assessment

Specific success metrics were established to compare potable water use, energy use, operating cost, economic payback, irrigation effectiveness and qualitative turf health (appearance) for the smart and control plots.

The smart water conservation system at NBVC met primary water reduction goals and all of the additional performance objectives with the exception of economic payback. In short, the system produced the following results:

- Overall, there was an 81 percent reduction in potable water use when comparing the smart and baseline plots.
- Overall energy usage was reduced by 57.4 percent.
- The ET controller's contribution towards water reduction was 55 percent.
- All smart water conservation system components achieved 100 percent operational availability during the monitoring phase.
- The calculated economic pay back for a new ET controller installation (without condensate and rainwater harvesting) was 5.2 years.
- The performance objective for economic payback set at 25 years was not achieved.

Not only does the smart water conservation system use less potable water, it also utilizes the water much more efficiently.

## The Basics About ESTCP & the NESDI Program

### ESTCP

ESTCP is DoD's environmental technology demonstration and validation program. Project researchers conduct formal demonstrations at DoD facilities and sites in operational settings to document and validate improved performance and cost savings. Demonstration results are subject to rigorous technical reviews to ensure that the conclusions are accurate and well supported by data.

For more information, visit www.serdp-estcp.org.

### The NESDI Program

The NESDI program seeks to provide solutions by demonstrating, validating and integrating innovative technologies, processes, materials and filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Fleet readiness. The program accomplishes this mission through the evaluation of cost-effective technologies, processes, materials and knowledge that enhance environmental readiness of naval shore activities and ensure they can be integrated into weapons system acquisition programs.

The NESDI program is the Navy's environmental shoreside (6.4) Research, Development, Test and Evaluation program. The program is sponsored by the Chief of Naval Operations Energy and Environmental Readiness Division and managed by the Naval Facilities Engineering Command out of NAVFAC EXWC in Port Hueneme, California. The NESDI program is the Navy's complement to ESTCP.

For more information, visit https://epl.navfac.navy.mil/nesdi. (A Common Access Card is required for access.)

## For More Information

**FOR MORE INFORMATION** on the smart water conservation system, visit the ESTCP website at https://www.serdp-estcp.org/index.php/Program-Areas/Energy-and-Water/Water-Conservation/EW-201019/EW-201019. A final report is also available for download by clicking on the "Final Report (posted 10/16)" hyperlink under the "Products" heading on the "Smart Water Conservation Systems for Irrigated Landscapes" webpage.

## Economic Feasibility

Economic payback and water reduction potential is determined on a case by case basis based on site-specific factors including local water cost, irrigation demand, roof size and water harvesting tank size. For example, if HVAC systems are not installed on rooftops, then a gravity-fed distribution system is not possible, necessitating the addition of pumps at additional cost. If air conditioning (A/C) units are decentralized, this also raises costs. And HVAC units that chill outside air will provide more condensate water than those units that intake re-circulated indoor air.

The smart water conservation system retrofitting at NBVC did not meet the economic payback period due to the high cost of the water harvest tank, relatively low cost of potable water at NBVC and the relatively small size of the smart turf plot. However, as the amount of irrigated landscape is increased, and/or the cost of water increases, the payback period will trend to a more favorable figure due to the substantial water reduction provided by the ET controller.


**A high-efficiency volume sprinkler nozzle and flow meter.**
*Gary Anguiano*

New development projects greater than 5,000 square feet are now required to implement "green infrastructure" or "low impact development" technologies to manage on-site stormwater runoff. Engineers should consider implementation of water harvesting as a means to manage stormwater to meet this requirement and couple it with an ET irrigation controller and efficient sprinkler hardware.

For substantive turf or landscape area retrofits, implementation of the sensors and ET controller makes the most economic sense since payback can be achieved in less than six years—particularly in sport fields in arid climates.

The ideal geographic areas in the southwestern United States to implement a smart water conservation system are locations such as Tucson, Arizona and Fort Hood, Texas, which receive monsoonal rains that replenish the water harvest tank during the summer months when demand is greatest. In addition, facilities in these locations are also known to generate large amounts of A/C condensate. Areas that have high local water costs or limited water supply options may also benefit from water harvest.

If a location meets the requirements stated above, the smart water conservation system, or its subcomponents, are likely a cost-effective choice. Not only does the system use less potable water, it also utilizes the water much more efficiently, providing irrigation precisely when and where it's needed most. The controller's automatic warning function also greatly reduces water loss through leakage and saves manpower through remote control operation. ⚓

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